OpenDA-OpenMI Framework

for Hydrological Data Assimilation

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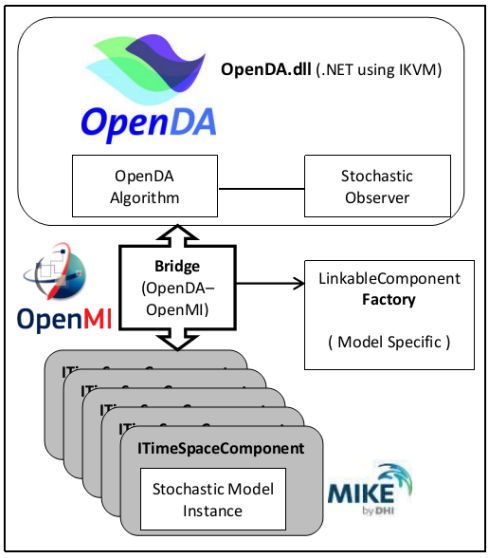
Overview

- Data Assimilation: Incorporate measurement information into an ensemble of model instances to improve results
- Open source & freely available
- Quickly connect any OpenMI model for assimilation - minimum effort and coding
- Robust, efficient and tested algorithms
- 6+ ensemble based filters

OpenDA-OpenMI Framework provides OpenMI compliant models, access to a suite of assimilation tools with minimal amount of programming.

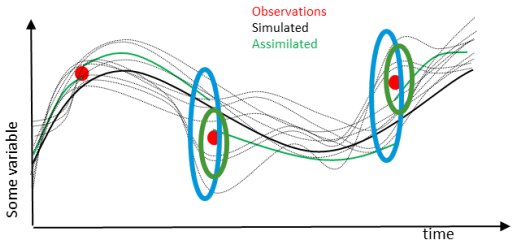


Data assimilation

- Incorporating measurement information into a model with the aim to improve model results by error minimisation
- Feedback process where model predictions are conditioned to the observations.

$$\mathbf{x}_k = \mathbf{M}(\mathbf{x}_{k-1}, \mathbf{u}_k, \theta, \epsilon_k)$$

$$\mathbf{X}_k^a = \mathbf{X}_k^f + \mathbf{K}_k(\mathbf{Y}_k - \mathbf{H}_k\mathbf{X}_k^f)$$



OpenDA

- Open interface standard and implementation of a set of tools to quickly implement data assimilation
- Library of algorithms designed for speed and efficiency for operational assimilation
- XML based configuration scheema
- User must define:
  1. Stochastic model instance
  2. Stocastic model factory
  3. Observation to model operator.

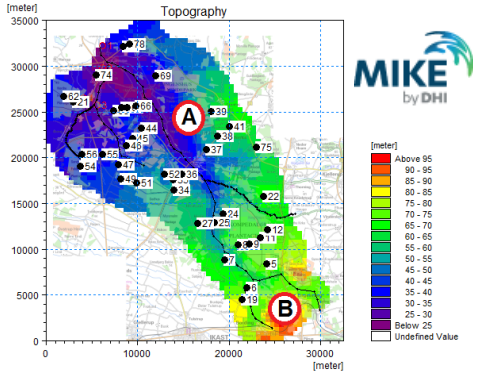
OpenMI

- Open Source standard interface for hydrological models
- Standard way to control hydrological models, pass data to and from the model during run time and definition of spatial standards
- Reference implementation in C#
- 12 major hydrological model providers (incl. DHI, British Geological Survey and Deltares)

Test Case

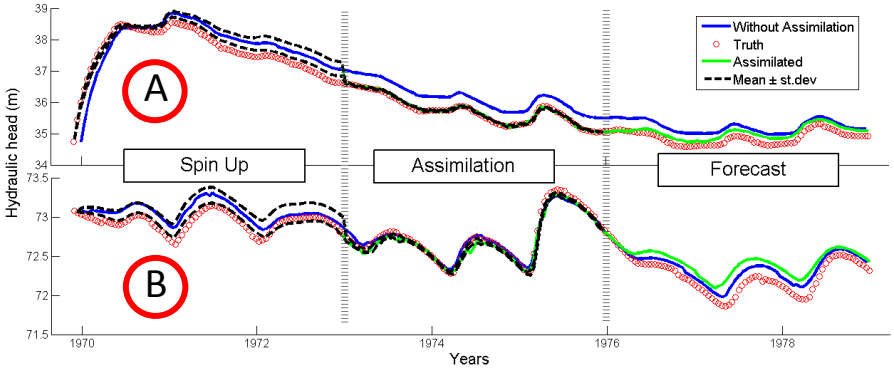
MIKE SHE - integrated catchment model (DHI)

- Karup river catchment (Denmark)[a]
- All major catchment processes at the surface (overland flow and river runoff), in the unsaturated zone (evapotranspiration and infiltration to the aquifer) and the saturated zone (groundwater flow and recharge)



Ensemble Kalman filter

- 30 Ensemble members
- Uncertainty based on GLUE (generalised likelihood uncertainty estimation)
- Daily hydraulic head observations (m = 35). Synthetic
- State updating (n = 522)



Reference

a) **R. Blasone**, *et al.*, 2008: *Uncertainty assessment of integrated distributed hydrological models using GLUE with Markov chain Monte Carlo sampling. Journal of Hydrology*, 353, p.18-32.